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E/ECE/TRANS/505 } Rev.1/Add.48/Rev.2/Amend.1

3 October 1996

AGREEMENT

CONCERNING THE ADOPTION OF UNIFORM TECHNICAL PRESCRIPTIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES AND THE CONDITIONS FOR RECIPROCAL RECOGNITION OF APPROVALS GRANTED ON THE BASIS OF THESE PRESCRIPTIONS */

(Revision 2, including the amendments entered into force on 16 October 1995)

Addendum 48: Regulation No. 49

Amendment 1

Incorporating:

Supplement 1 to the 02 series of amendments - date of entry into force : 18 May 1996
Supplement 2 to the 02 series of amendments - date of entry into force : 28 August 1996
Corrigendum 2 to the 02 series of amendments - depositary notification C.N. 353.1995.TREATIES-72 of 13 November 1995

UNIFORM PROVISIONS CONCERNING THE APPROVAL OF COMPRESSION IGNITION (C.I.) ENGINES AND VEHICLES EQUIPPED WITH C.I. ENGINES WITH REGARD TO THE EMISSIONS OF POLLUTANTS BY THE ENGINE

UNITED NATIONS

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*/ Former title of the Agreement:

Agreement Concerning the Adoption of Uniform Conditions of Approval and Reciprocal Recognition of Approval for Motor Vehicle Equipment and Parts, done at Geneva on 20 March 1958.

GE.96-24173

Title of the Regulation, amend to read:

"UNIFORM PROVISIONS CONCERNING THE APPROVAL OF COMPRESSION-IGNITION (C.I.) AND NATURAL GAS (N.G.) ENGINES AS WELL AS POSITIVE-IGNITION (P.I.) ENGINES FUELLED WITH LIQUEFIED PETROLEUM GAS (LPG) AND VEHICLES EQUIPPED WITH C.I. AND N.G. ENGINES AND P.I. ENGINES FUELLED WITH LPG, WITH REGARD TO THE EMISSIONS OF POLLUTANTS BY THE ENGINE"

Contents, list of annexes,

Title of annex 2A, amend the words "C.I. engine" to read "C.I. or N.G. engine".

Title of annex 5, amend the words "reference fuel" to read "reference fuel for C.I. engines".

Insert the title of a new annex 6, to read:

"Annex 6 Technical characteristics of reference N.G. fuel prescribed for approval tests and to verify conformity of production"

Text of the Regulation

Paragraph 1, amend to read:

"1. SCOPE

This Regulation applies to the emission of gaseous and particulate pollutants from C.I. and N.G. engines and P.I. engines fuelled with LPG, used for driving motor vehicles having a design speed ...."

Footnote 2/ pertinent to paragraph 1, amend to read:

"2/ Engines used by category N1, N2, and M2 ...."

Insert a new paragraph 2.4., to read:

"2.4. "Natural gas engine" means an engine which is fuelled with natural gas (N.G.);"

Paragraphs 2.4. and 2.5. (former), renumber as paragraphs 2.5. and 2.6.

Paragraph 2.6. (former), renumber as paragraph 2.7. and amend to read:

"2.7. "gaseous pollutants" means carbon monoxide, hydrocarbons (assuming a ratio of $C_1H_{1.85}$ for C.I. engines, $C_1H_{3.76}$ for N.G. engines and $C_1H_{2.61}$ for LPG engines) and oxides of nitrogen, the last named being expressed in nitrogen dioxide (NO_2) equivalent."

Paragraphs 2.7. and 2.8. (former), renumber as paragraphs 2.8. and 2.9.

Paragraph 2.9. (former), renumber as paragraph 2.10. and amend to read:

"2.10. "rated speed" means the maximum full load speed allowed by the governor as specified by the manufacturer in his sales and service literature, or, if such a governor is not present, the speed at which the maximum power is obtained from the engine, as specified by the manufacturer in his sales and service literature."

Paragraphs 2.10. to 2.12. (former), renumber as paragraphs 2.11. to 2.13.

Paragraph 2.13. (former), renumber as paragraph 2.14. and insert after the abbreviation "conc" the following new abbreviations:

"conc W	ppm	concentration (ppm by volume) wet
conc D	ppm	concentration (ppm by volume) dry"

and further, insert the following new abbreviation after "G_{AIR}" and before "$V"_{AIR}$":

"V'_{AIR}	m^3/h	intake air volume flow rate on a dry basis;"

Paragraph 3.1.2., amend to read:

"3.1.2. It shall be accompanied by the necessary documents in triplicate. It will at least include the essential characteristics of the engine as referred to in annex 1 to this Regulation."

Paragraph 3.2.2., amend to read:

"3.2.2. It shall be accompanied by the necessary documents in triplicate. It will at least include:

The essential characteristics of the engine as referred to in annex 1;

A description of the engine related components as referred to in annex 1;

A copy of the type approval communication form (annex 2A) for the engine type installed."

Paragraph 8.1., amend to read:

"8.1. The approval granted in respect of an engine or vehicle type pursuant to this Regulation may be withdrawn if the requirements laid down in paragraph 7.1. are not complied with, or if the engine(s) or vehicle(s) taken fail to pass the tests prescribed in paragraph 7.4."

Annex 1, "ESSENTIAL CHARACTERISTICS OF THE ENGINE AND INFORMATION CONCERNING THE CONDUCT OF TEST"

Item 1.11., amend to read:

"1.11. Combustion system description:
compression ignition/spark ignition 1/"

Insert a new item 1.12., to read:

"1.12. Fuel: Diesel fuel/Natural gas 1/"

Items 1.12. to 1.15.4. (former), renumber as items 1.13. to 1.16.4.

Item 1.15.5. (former), renumber as item 1.16.5. and amend to read:

"1.16.5. Fuel temperature: min: ....K, max: .....K, for C.I. engine at the injection pump inlet, and for N.G. engines at pressure regulator final stage."

Insert a new item 1.16.6., to read:

"1.16.6. For N.G. engines: Fuel pressure: min: ....kPa, max: ....kPa, at pressure regulator final stage"

Items 1.15.6. to 1.18. (former), renumber as items 1.16.7. to 1.19.

Insert new items 1.20. and 1.21., to read:

"1.20. Maximum net power ..... kW at ..... min^{-1}
1.21. Maximum net torque ..... Nm at ..... min^{-1}"

Item 2, replace by the following text:

"2. Measures taken against air pollution

2.1. Additional pollution control devices (if any, and if not covered by another heading) . . . . . .

2.1.1. Catalytic converter: yes/no 1/

2.1.1.1. Number of catalytic converters and elements: . . . . . .

2.1.1.2. Dimensions and shape of the catalytic converter(s) (volume,...): . . . . . .

2.1.1.3. Type of catalytic action: . . . . . .

2.1.1.4. Total charge of precious metal: . . . . . .

2.1.1.5. Relative concentration: . . . . . .

2.1.1.6. Substrate (structure and material): . . . . . .

2.1.1.7. Cell density: . . . . . .

2.1.1.8. Type of casing for catalytic converter(s): . . . . . .

2.1.1.9. Positioning of the catalytic converter(s) (place and reference distances in the exhaust system): . . . . . .

2.1.1.10. Oxygen sensor: type . . . . . .

2.1.1.10.1. Location of oxygen sensor: . . . . . .

2.1.1.10.2. Control range of oxygen sensor: . . . . . .

2.2. Air injection: yes/no 1/

2.2.1. Type (pulse air, air pump,...) . . . . . .

2.3. Exhaust Gas Recycle (EGR): yes/no 1/

2.3.1. Characteristics (flow...): . . . . . .

2.4. Other systems (description and working): . . . . . "

Insert a new item 3.1., to read:

"3.1. By fuel injection : (C.I. engines only): yes/no 1/"

Items 3.1. to 3.3.3. (former), renumber as items 3.1.1. to 3.1.3.3.

Insert new items 3.2. to 3.4.6.5., to read:

"3.2. By mixing unit (N.G. engines only): yes/no 1/

3.2.1. Pressure regulator: . . . . . .

3.2.1.1. Make(s): . . . . . .

3.2.1.2. Type(s): . . . . . .

3.2.1.3. Pressure in the final stage max:..... kPa; min: . . . . . kPa:

3.2.1.4. Starting idling system . . . . . .

3.2.1.5. Idling regulation . . . . . .

3.2.2. Mixture strength regulation . . . . . .

3.2.3. Mixing unit . . . . . .

3.2.3.1. Make(s): . . . . . .

3.2.3.2. Type(s): . . . . . "

3.3. By fuel injection (N.G. engines only) yes/no 1/

3.3.1. System description: . . . . . .

3.3.2. Working principle: intake manifold (single/multi-point)/direct injection/other (specify)

Control unit - type (or No.):	Information to be given in the case of continuous injection; in the case of other system, equivalent details
Fuel regulator - type:	
Air flow sensor- type:	
Fuel distributor-type:	
Pressure regulator-type:	
Microswitch-type:	
Idle adjusting screw-type:	
Throttle housing-type:	
Water temperature sensor-type:	
Air temperature sensor-type:	
Air temperature switch-type:	

Electromagnetic interference protection. Description and/or drawing

3.3.3. Make(s): . . . . . .

3.3.4. Type(s): . . . . . .

3.3.5. Injectors: Opening pressure: 2/ . . . . . kPa
or characteristic diagram: 2/ . . . . . .

3.3.6. Injection timing: . . . . . .

3.3.7. Cold start system: . . . . . .

3.3.7.1. Operating principle(s): . . . . . .

3.3.7.2. Operating limits/settings: 1/, 2/ . . . . . .

3.4. For LPG-fuelled engines: . . . . . .

3.4.1. Evaporator/pressure regulator: . . . . . .

3.4.1.1. Make(s): . . . . . .

3.4.1.2. Type(s): . . . . . .

3.4.1.3. Certification number: . . . . . .

3.4.1.4. Identification: . . . . . .

3.4.1.5. Drawings: . . . . . .

3.4.1.6. Number of main adjustment points: . . . . . .

3.4.1.7. Description of principle of adjustment through main adjustment points: . . . . . .

3.4.1.8. Number of idle adjustment points: . . . . . .

3.4.1.9. Description of principles of adjustment through idle adjustment points: . . . . . .

3.4.1.10. Other adjustment possibilities (if so and which): . . . . . .

3.4.2. By LPG carburation equipment: yes/no 1/

3.4.2.1. System description: . . . . . .

3.4.2.1.1. Make(s): . . . . . .

3.4.2.1.2. Type(s): . . . . . .

3.4.3. Mixing piece: yes/no 1/ . . . . . .

3.4.3.1. Number: . . . . . .

3.4.3.2. Make(s): . . . . . .

3.4.3.3. Identification: . . . . . .

3.4.3.4. Drawings: . . . . . .

3.4.3.5. Place of installation: . . . . . .

3.4.3.6. Adjustment possibilities: . . . . . .

3.4.4. By injection equipment: yes/no 1/

3.4.4.1. Number: . . . . . .

3.4.4.2. Make(s): . . . . . .

3.4.4.3. Identification: . . . . . .

3.4.4.4. Drawings: . . . . . .

3.4.4.5. Place of installation: . . . . . .

3.4.4.6. Adjustment possibilities: . . . . . .

3.4.4.7. Injector(s) : yes/no 1/ . . . . . .

3.4.4.7.1. Make(s): . . . . . .

3.4.4.7.2. Type(s): . . . . . .

3.4.4.7.3. Identification: . . . . . .

3.4.5. Electronic Control Unit LPG-fuelling:

3.4.5.1. Make(s): . . . . . .

3.4.5.2. Identification: . . . . . .

3.4.5.3. Adjustment possibilities: . . . . . .

3.4.6. Further documentation: . . . . . .

3.4.6.1. Description of the LPG-equipment and the physical safeguarding of the catalyst at switch-over from petrol to LPG or back: . . . . . .

3.4.6.2. System lay-out (electrical connections, vacuum connections, compensation hoses, etc.): . . . . . .

3.4.6.3. Drawing of the symbol: . . . . . .

3.4.6.4. Adjustment data: . . . . . .

3.4.6.5. Certificate of the vehicle on petrol, if already granted: . . . . . "

Insert new items 4 to 4.10.2., to read:

"4. Ignition system (spark ignition engines only)

4.1. Make(s): . . . . . .

4.2. Type(s): . . . . . .

4.3. Working principle: . . . . . .

4.4. Ignition advance curve: 2/ . . . . . .

4.5. Static ignition timing: 2/..... degrees before TDC . . . . .

4.6. Contact-point gap: 2/ . . . . . .

4.7. Dwell-angle: 2/ . . . . . .

4.8. Spark plugs:

4.8.1. Make(s): . . . . . .

4.8.2. Type(s): . . . . . .

4.8.3. Spark plug gap setting: . . . . . mm

4.9. Ignition coil:

4.9.1. Make(s): . . . . . .

4.9.2. Type(s): . . . . . .

4.10. Ignition condenser:

4.10.1. Make(s): . . . . . .

4.10.2. Type(s): . . . . . .

Items 4 to 7.1. (former), renumber as items 5 to 8.1.

Item 7.2. (former), renumber as item 8.2. and in the table, column "Condition", line (c), amend the text to read "Engine power (kW) (c)", and further, footnote 1/ pursuant to this item, amend to read:

"1/ Measured values, not corrected to standard conditions."

Annex 2A, "COMMUNICATION", amend the title to read:

"....
of a compression-ignition (C.I.) engine type / of a natural gas (N.G.) engine type 2/ or a positive-ignition (P.I.), LPG-fuelled engine type 2/, as a separate technical unit with regard ...."

Insert new items 3 and 3.1., to read:

"3. Combustion type: compression-ignition/positive-ignition 2/

3.1. Type of fuel: . . . . . "

Items 3 to 18 (former), renumber as items 4 to 19.

Annex 4 "TEST PROCEDURE",

Paragraph 2.2., delete the formula and insert new paragraphs 2.2.1. and 2.2.2., to read:

"2.2.1. C.I. engines

$$F = \left(\frac{99}{ps}\right) \times \left(\frac{T}{298}\right)^{0.7}$$

2.2.2. Spark ignition engines

$$F = \left(\frac{99}{ps}\right)^{0.65} \times \left(\frac{T}{298}\right)^{0.5}$$ "

Paragraph 2.3., delete the formula and insert new paragraphs 2.3.1. and 2.3.2., to read:

"2.3.1. C.I. engines

$$F = \left(\frac{99}{ps}\right)^{0.7} \times \left(\frac{T}{298}\right)^{1.5}$$

2.3.2. Spark ignition engines

$$F = \left(\frac{99}{ps}\right)^{0.65} \times \left(\frac{T}{298}\right)^{0.5}$$ "

Paragraph 3, amend to read:

"3. Fuel

The fuel shall be the reference fuel specified in annex 5 for C.I. engines and in annex 6 for N.G. engines."

Insert a new paragraph 3.1., to read:

"3.1. In the case of LPG, the fuel shall be of commercial quality, of which density and heating value shall be determined and noted in the report."

Paragraph 4.1., amend the heading "Engine Speed" of the cycle description to read "Engine Test Speed".

Paragraph 4.2., amend to read:

"..... to within ± 2 % of the maximum torque at the engine test speed. In the case of C.I engines the fuel at the injection pump inlet must be306-316 K (33°C - 43°C). The governor and fuel system must be adjusted as established by the manufacturer's sale and service literature.

In the case of N.G. engines the fuel temperature and the pressure at pressure regulator final stage shall be within the range specified by the manufacturer; the speed limiting device and fuel system must be adjusted as established by the manufacturer's sales and service literature.

The following steps are taken for each test:"

Paragraph 4.2.4., amend to read:

"4.2.4. the torque curve at full load must be determined by experimentation to calculate the torque values for the specified test modes and to check the conformity of the tested engine performance with manufacturer's specifications. The corrected performance shall not differ by more than ± 2% for maximum net power and ± 4% for maximum

net torque from the values declared by the manufacturer. The maximum permissible power absorbed by engine-driven equipment ...."

Annex 4 - Appendix 1,

(Note: corrigendum to Revision 2 of the Regulation, English only, headers on pages 30, 32 and 34, amend the words "Annex 1 - Appendix 1" to read "Annex 4 - Appendix 1").

Paragraph 2.1.2.1., amend to read:

"2.1.2.1. Temperatures

Exhaust gas temperature shall be measured with an accuracy of ± 5K (5°C), other temperatures with an accuracy of ± 1.5K (1.5°C)."

Paragraphs 2.1.4. and 2.1.5., amend to read:

"2.1.4. where there is a risk of an appreciable effect on the engine power, or when the manufacturer requests so, the complete exhaust system shall be fitted as provided for the intended application, non-insulated and uncooled, extending at least 0.5 m past the point where the raw exhaust sample probes are located.

In other cases, an equivalent system may be installed provided the pressure measured at the exit of the engine exhaust system does not differ by more than 1,000 Pa from that specified by the manufacturer.

The exit from the engine exhaust system is defined as a point 150 mm downstream from the termination of the part of the exhaust system mounted on the engine.

2.1.5. where there is a risk of an appreciable effect on the engine power, or when the manufacturer requests so, the complete intake system shall be fitted as provided for the intended application.

In other cases, an equivalent system may be used and a check should be made to ascertain that the intake pressure does not differ by more than 100 Pa from the limit specified by the manufacturer for a clean air filter."

Paragraph 2.2.,

Items (a) and (b), renumber as paragraphs 2.2.1. and 2.2.2.

At the end of the new paragraph 2.2.2. ("... following equations:"), insert new paragraphs 2.2.2.1. and 2.2.2.2. to read (comprising also the existing text and equations):

"2.2.2.1. In the case of C.I. engine:

$$G_{EXH} = G_{AIR} + G_{FUEL}$$

or

$V'_{EXH} = V'_{AIR} - 0.75\ G_{FUEL}$ (dry exhaust volume)

or

$V''_{EXH} = V''_{AIR} + 0.77\ G_{FUEL}$ (wet exhaust volume)

The accuracy ..... method used."

2.2.2.2. In the case of N.G. engines:

$G_{EXH} = G_{AIR} + G_{FUEL}$

or

$V'_{EXH} = V'_{AIR} - 1.35\ G_{FUEL}$

or

$V''_{EXH} = V''_{AIR} + 1.36\ G_{FUEL}$ (wet exhaust volume)

The accuracy of exhaust flow determination shall be ± 2.5% or better."

Insert a new paragraph 2.2.2.3., to read:

"2.2.2.3. In the case of LPG-fuelled engines:

$V'_{EXH} = V''_{AIR} - G_{FUEL}$ (dry exhaust volume)

or

$V''_{EXH} = V''_{AIR} + G_{FUEL}$ (wet exhaust volume)"

Paragraph 2.3.4., amend to read:

".... A second heated sample line for NO_x analysis is to be used, when appropriate. The temperature of this line ...."

Annex 4 - Appendix 2,

Paragraph 2.1., amend to read:

"....
The following gases must be available for calibration and operation:
.....
(Oxygen content between 18 and 21% vol.);
Propane (Purity 99.5% minimum)."

Paragraph 4.4.4., amend the words "gas flow" to read "span gas flow".

Paragraph 4.4.8., amend the symbol "NO_2" to read "NO".

Paragraph 4.4.11., the "NOTE", amend the words "NO_x generator" to read "NO_x converter".

Annex 4 - Appendix 3,

Paragraph 1.1.2.1., amend to read:

"..... according to the following relationship:

1.1.2.1.1. In the case of C.I. engine:

ppm (wet basis) = ppm (dry basis) x $(1-1.85\ G_{FUEL}/G_{AIR})$

where:

G_{FUEL} is the fuel flow (kg/s) (kg/h)

G_{AIR} is the air flow (kg/s) (kg/h) (dry air)

1.1.2.1.2. In the case of N.G. engine:

concW (wet basis) = concD (dry basis) x (V'_{EXH}/V''_{EHX})

where:

V'_{EXH} and V''_{EXH} are calculated according to paragraph 2.2.2.2. of annex 4 - appendix 1"

Insert a new paragraph 1.1.2.1.3., to read:

"1.1.2.1.3. In the case of LPG-fuelled engines:

ppm (wet basis) = ppm (dry basis) x $(1-2.40\ G_{FUEL}/G_{AIR})$

where:

G_{FUEL} is the fuel flow (kg/s) (kg/h)
G_{AIR} is the air flow (kg/s) (kg/h) (dry air)"

Paragraph 1.1.3., amend to read:

"1.1.3. The NOx concentration shall be corrected for humidity according to paragraph 1.1.3.1. below for C.I. engines and paragraph 1.1.3.2. below for N.G. engines."

Paragraph 1.1.3.1., amend to read:

"1.1.3.1. C.I. engine NOx correction factor:

The values of the oxides of ....."

Insert a new paragraph 1.1.3.2., to read:

"1.1.3.2. N.G. engines NOx correction factor:

The values of the oxides of nitrogen shall be multiplied by the following humidity correction factor (KNOx):

$KNOx = 0.6272 - 0.04403\ H - 0.0008625\ H^2$

where:
H = humidity of the inlet air in g of H_2O per kg dry air (see paragraph 1.1.3.1.)"

Paragraph 1.1.4., amend to read:

"1.1.4. The pollutant mass flow for each mode shall be calculated as follows (only C.I. engines) .....:"

Insert a new paragraph 1.1.5., to read:

"1.1.5. The pollutant mass flow for N.G. engine and for mode, assuming the density of exhaust gas equal to 1.249 kg/m^3, shall be calculated as follows:

(1) $NO_{x\ mass} = 0.001641 \times NO_{x\ concW} \times G_{EXH}$

(2) $CO_{mass} = 0.001001 \times CO_{concW} \times G_{EXH}$

(3) $HC_{mass} = 0.000563 \times HC_{concW} \times G_{EXH}$ 1/

or:

(1) $NO_{x\ mass} = 0.00205 \times NO_{x\ concD} \times V'_{EXH\ (dry)}$

(2) $CO_{mass} = 0.00125 \times CO_{concD} \times V'_{EXH\ (dry)}$

(3) $HC_{mass} = 0.000703 \times HC_{concD} \times V'_{EXH\ (dry)}$ 1/

1/ For HC ($CH_{3.76}$), the concentration shall be expressed in carbon equivalent (i.e. equivalent propane x 3)".

Paragraph 1.1.5. (former), renumber as paragraph 1.1.6 and amend as follows:

Insert after the third formula (for $\overline{HC}$) the words:

"P_i are measured values".

Insert a new paragraph 1.1.6., to read:

"1.1.6. The pollutant mass flow for LPG-fuelled engine and for mode, shall be calculated as follows:

(1) NO_x mass = 0.001587 x NO_x conc x G_{EXH}
(2) CO_{mass} = 0.000966 x CO_{conc} x G_{EXH}
(3) HC_{mass} = 0.000505 x HC_{conc} x G_{EXH}

or,

(1) NO_x mass = 0.00205 x NO_x conc x V'_{EXH} (dry)
(2) NO_x mass = 0.00205 x NO_x conc x V''_{EXH} (wet)
(3) CO_{mass} = 0.00125 x CO_{conc} x V'_{EXH} (dry)
(4) HC_{mass} = 0.000653 x HC_{conc} x V''_{EXH} (wet)"

Paragraph 1.1.6. (former), renumber as paragraph 1.1.7.

Paragraph 1.2., insert the following text after the formula:

"where: WF - as in paragraph 1.1.5. above."

Paragraph 1.3.3., amend to read:

"1.3.3. Total sampling type with CO_2 measurement and carbon balance method

$$G_{EDF,i} = \frac{206 \times G_{FUEL,i}}{CO_{2D,i} - CO_{2A,i}} \qquad (C.I.\ engines)$$

or,

$$G_{EDF,i} = \frac{195 \times G_{FUEL,i}}{CO_{2D,i} - CO_{2A,i}} \qquad (LPG\text{-}fuelled\ engines)$$

where:

....."

Annex 4 - Appendix 4,

Paragraph 1, insert a reference to footnote 1/, and a new footnote 1/, to read:

"1/ In the case of LPG-fuelled engines, unheated sample lines and instruments are acceptable for the measurement of HC and NO_x."

Paragraph 1.1. "SYSTEM 1 (HCLA OR EQUIVALENT SYSTEM)",

Item SP, insert at the end the following text:

"In the case of N.G. engine, the sample probe shall be installed at minimum 1.5 m and maximum 2.5 m from exhaust manifold or turbocharger flange".

Annex 5,

The title, amend to read:

"..... REFERENCE FUEL FOR C.I. ENGINES ....."

Insert a new annex 6, to read:

"Annex 6

TECHNICAL CHARACTERISTICS OF REFERENCE N.G. FUEL PRESCRIBED FOR APPROVAL TESTS AND VERIFY CONFORMITY OF PRODUCTION

Type: Natural gas

	Characteristic	Units	Limits min.	Limits max.	Test methods
1	Density	kg/m^3 (*)	0.680	0.720	ISO 6976 (ASTM D 3588)
2	Calorific value - upper	kJ/m^3 (*)	36900	39300	
	Calorific value - low		33300	35400	
3	Composition				
	Methane	%Mole	97.5	99.9	ISO 6974 (ASTM D 1945
	Ethane		-----	1	
	Propane/Butane		-----	0.8	
	C5/C5+		-----	0.6	
	Inerts		-----	2.1	
	Sulphur content	mg/m^3 (*)	-----	80.00	(1)

(*) Value to be determined in standard condition (288 K (15 °C) and 101,325 kPa)

(1) Analysis of sulphuretted hydrogen and mercaptans concentration in natural gas

- The analysis is performed by means of a gaschromatograph equipped with a flame photometry detector with sulphur selective filter.

- Test conditions:

columns GS-9 30m x 0.53 mm ID (J&W)

T injector = 150°C

T detector = 200°C

T oven = 2 min at 70°C → 6°C min at 200°C

conveying gas = nitrogen 30 ml/min

Sample introduction

by means of a gas sampling valve or gas nozzle

introduced volume = 100 µl

The concentration is calculated by comparison with an external standard. It is better to introduce standards with different concentration levels so as to build a calibration curve."